

Appln No. 09/529,483

Amdt date August 20, 2003

Reply to Office action of April 24, 2003

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

D 1. (Currently Amended) An MR imaging method for imaging and determining the position of a medical device, the medical device having a passive resonance circuit with an inductor and a capacitor, the inductor being integrated into or formed by an unfolding portion of the medical device that at least in part is capable of being unfolded when inserted in an examination object, the method comprising:

arranging the examination object in an external magnetic field,

applying high-frequency radiation ~~of~~ having a specific resonance frequency essentially equal to a resonance frequency of the passive resonance circuit so that transitions between spin energy levels of the atomic nuclei of the examination object are excited, and MR signals are produced,

detecting the MR signals as signal responses, which are evaluated and imaged in spatial resolution,

unfolding the unfolding portion of the device after insertion into the examination object such that the inductor formed by or integrated into the unfolding portion unfolds along with the unfolding portion, and

producing, by means of the device, a changed signal response of the examination object in a locally defined area with the device, and

Appln No. 09/529,483

Amdt date August 20, 2003

Reply to Office action of April 24, 2003

detecting the changed signal response of the examination object to determine the position of the medical device

~~wherein the device includes a passive resonance circuit with an inductor and a capacitor, the circuit having a resonance frequency essentially equal to the resonance frequency of the applied high-frequency radiation, and~~

~~wherein the inductor is located in an unfolded part of the device in an area to be imaged with the changed signal response.~~

D 2. (Previously Amended) The method according to Claim 1 wherein the application of the high-frequency radiation excites the resonance circuit so that the excitation of the nuclear spins of the examination object is amplified in the locally defined area.

3. (Previously Amended) The method according to Claim 2 wherein the locally defined area where the amplification of the excitation of the nuclear spins takes place is located in a compartment formed within the device and surrounded by the inductor.

4. (Previously Amended) The method according to Claim 2 wherein the locally defined area where the amplification of the excitation of the nuclear spins takes place is outside the device and adjacent thereto, and wherein at least one resonance circuit is arranged on the surface of the device such that with the application of high-frequency radiation, the magnetic flow in the adjacent area is amplified.

Appln No. 09/529,483

Amdt date August 20, 2003

Reply to Office action of April 24, 2003

5. (Previously Amended) The method according to Claim 1 wherein when high-frequency radiation is applied to the resonance circuit, the circuit becomes detuned or the capacitor is short circuited to the extent that no amplified excitation of the nuclear spins takes place in the locally defined area, but wherein when the signal response of the locally defined area is measured, the detuning of the resonance circuit or the short circuiting of the capacitance is canceled and results in a change in the signal response.

6. (Previously Amended) The method according to Claim 1, 2, 3, 4, or 5 wherein the resonance circuit is adjusted to the resonance frequency by unfolding the device after insertion of the device into the examination object.

DI 7. (Previously Amended) The method according to Claim 1 wherein at least one of the inductor and the capacitor are adjusted for the resonant tuning of the resonance circuit.

8. (Previously Amended) The method according to Claim 1 wherein the device has at least two resonance circuits whose inductors have coils, and wherein the coils of the respective inductors are oriented differently from each other.

9. (Currently Amended) A medical device that at least in part is capable of being unfolded comprising:

at least one passive resonance circuit having an inductor and a capacitor, whose resonance frequency is essentially equal

Appln No. 09/529,483

Amdt date August 20, 2003

Reply to Office action of April 24, 2003

to a resonance frequency of ~~of~~ an MR imaging system's applied high-frequency radiation, wherein the at least one passive resonant circuit shifts excitation of spin energy levels of atomic nuclei of an examination object to generate an enhanced MR signal in a locally defined area, and wherein a part of the device that is capable of being unfolded forms the inductor or the inductor is integrated into such a part, such that the inductor unfolds along with the device when the device is unfolded.

10. (Previously Amended) The device according to Claim 9, wherein the inductor is formed or arranged on the surface of the device.

11. (Previously Amended) The device according to Claim 9 or 10, wherein the inductor is formed by a conductor which runs on the surface of the device.

D¹ 12. (Previously Amended) The device according to Claim 11, wherein the inductor is formed on a foil which is adhered to the surface of the device.

13. (Currently Amended) The device according to Claim ~~8 or~~ 10, wherein the inductor is formed from the material of the device.

14. (Previously Amended) The device according to Claim 9, wherein the device is elongated in shape and has a

Appln No. 09/529,483

Amdt date August 20, 2003

Reply to Office action of April 24, 2003

longitudinal axis, the inductor is formed as a coil having an axis, and the axis of the inductor runs substantially parallel to the longitudinal axis of the device.

15. (Previously Amended) The device according to Claim 14, wherein the inductor is formed by a conductor arranged on the surface of the device in the shape of at least a single helix.

16. (Previously Amended) The device according to Claim 9, wherein the device is elongated in shape and has a longitudinal axis, the inductor is formed as a coil having an axis, and the axis of the inductor runs substantially perpendicular to the longitudinal axis of the device.

17. (Previously Amended) The device according to Claim 16, wherein the inductor is formed by a spiral-shaped conductor formed or arranged on the surface of the device.

18. (Previously Amended) The device according to Claim 9, wherein the device has a plurality of resonance circuits with a plurality of inductors.

19. (Previously Amended) The device according to Claim 9, wherein the device has means for detuning at least one resonance circuit with the application of high-frequency radiation.

Appln No. 09/529,483

Amdt date August 20, 2003

Reply to Office action of April 24, 2003

20. (Previously Amended) The device according to Claim 19, wherein the detuning means are designed such that they switch a condenser parallel to the capacitor of the resonance circuit with the application of high-frequency radiation.

21. (Previously Amended) The device according to Claim 19, wherein the detuning means are designed such that they switch a coil parallel to the inductor of the resonance circuit with the application of high-frequency radiation.

D1 22. (Previously Amended) The device according to Claim 9, wherein the device is provided with means to short circuit the capacitor when applying high-frequency radiation.

23. (Previously Amended) The device Claim 22, wherein the means for short circuiting the capacitor comprises two diodes which are switched parallel to the capacitor.

24. (Previously Amended) The device according to Claim 9, wherein a switch is provided by which the at least one resonance circuit can be activated or deactivated.

25. (Previously Amended) The device according to Claim 9, wherein at least one of the inductor and the capacitor of the resonance circuit are adjustable for tuning to the resonance frequency of the MR system.

Appln No. 09/529,483

Amdt date August 20, 2003

Reply to Office action of April 24, 2003

26. (Previously Amended) The device according to Claim 9, wherein the resonance circuit has a plurality of parallel or serially switched inductors and/or capacitors.

27. (Previously Amended) The device according to Claim 9, wherein the device is a balloon catheter having an axis and an outer skin on which a spiral-shaped or helix-shaped inductor is formed.

28. (Previously Amended) The device according to Claim 27, wherein the capacitor is in the form of parallel conductors which run along the axis of the balloon catheter.

29. (Previously Amended) The device according to Claim 9, wherein the device is a vena cava filter having elongated, movable toothed elements and the inductor is attached to the toothed elements.

30. (Previously Amended) The device according to Claim 29, wherein at least one of the inductor and capacitor are made of the same material as the vena cava filter.

31. (Currently Amended) An MR imaging system for performance of the method according to Claim 1 imaging an examination object having a medical device inserted therein, the medical device having a passive resonance circuit with an inductor and a capacitor, the inductor being integrated into or formed by an unfolding portion of the medical device that at

Appln No. 09/529,483

Amdt date August 20, 2003

Reply to Office action of April 24, 2003

least in part is capable of being unfolded when inserted in the examination object, the imaging system comprising:

an imaging apparatus adapted to apply high-frequency radiation having a specific resonance frequency essentially equal to the resonance frequency of the passive circuit so that transitions between spin energy levels of the atomic nuclei of the examination object are excited, and MR signals are produced,

the imaging apparatus being further adapted to detect the MR signals as signal responses, which are evaluated and imaged in spatial resolution,

wherein the medical device modifies the transitions between spin energy levels of the atomic nuclei of the examination object to change the signal response of the examination object in a locally defined area and wherein the imaging apparatus is further adapted to detect the changed signal response of the examination object to determine the position of the medical device.

32. (Currently Amended) An MR imaging system ~~having a device according to Claim 9~~ comprising:

a medical device that at least in part is capable of being unfolded, the medical device comprising,

at least one passive resonance circuit having an inductor and a capacitor, whose resonance frequency is essentially equal to a resonance frequency of an MR imaging system's applied high-frequency radiation,

wherein the at least one passive resonant circuit shifts excitation of spin energy levels of atomic nuclei of an

Appln No. 09/529,483

Amdt date August 20, 2003

Reply to Office action of April 24, 2003

examination object to generate an enhanced MR signal in a locally defined area, and

wherein a part of the device that is capable of being unfolded forms the inductor or the inductor is integrated into such a part, such that the inductor unfolds along with the device when the device is unfolded.

33. (Previously Added) The method according to Claim 1 wherein the medical device is selected from a vena cava filter or a balloon catheter.

34. (Canceled)

35. (Previously Added) The method according to claim 8 wherein the inductors are aligned one of perpendicularly to each other and behind each other.

36. (Previously Added) The medical device according to Claim 9 selected from a vena cava filter or a balloon catheter.

37. (Previously Added) The device according to Claim 15 wherein the helix is a double or multiple helix.

D/ 38. (Previously Added) The device according to Claim 18 wherein the plurality of inductances are arranged perpendicularly relative to each other or arranged behind each other.

Appln No. 09/529,483

Amdt date August 20, 2003

Reply to Office action of April 24, 2003

39. (New) An MR imaging method for imaging and determining position of a medical device, the medical device having a passive resonance circuit with an inductor and a capacitor, the inductor being integrated into an unfolding portion of the medical device which is unfoldable in an examination object under examination, the method comprising:

applying high-frequency radiation to an examination object after the medical device is unfolded therein such that the inductor integrated into the unfolding portion unfolds along with the unfolding portion, the high frequency radiation having a specific resonance frequency approximately equal to a resonance frequency of the passive resonance circuit to excite transitions between spin energy levels of the atomic nuclei of the examination object, and produce MR signals,

exciting the resonance circuit, wherein the excited resonance circuit amplifies the excitation of transitions between spin energy levels of the atomic nuclei of the examination object in a locally defined area to produce amplified MR signals; and

detecting the amplified MR signals to determine the position of the medical device.

D | 40. (New) The method of claim 39 further comprising unfolding the unfolding portion of the device, after insertion into the examination object, along with the inductor.

41. (New) The method of claim 39 further comprising adjusting the resonance frequency of the passive resonance

Appln No. 09/529,483

Amdt date August 20, 2003

Reply to Office action of April 24, 2003

circuit by unfolding the unfolding portion of the device, after insertion into the examination object, along with the inductor.

42. (New) A medical device for use in an MR imaging system, the medical device comprising,

a passive resonance circuit having an inductor and a capacitor, the inductor being integrated into an unfolding portion of the medical device, such that the inductor unfolds with the unfolding portion of the medical device after insertion in an examination object, wherein

a resonance frequency of the passive resonance circuit is approximately equal to a resonance frequency of radiation applied by the MR imaging system.

DI 43. (New) The medical device of claim 42 wherein the passive resonant circuit shifts excitation of spin energy levels of atomic nuclei of an examination object to generate an enhanced MR signal in a locally defined area.
